PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. V. 1864–65. No. 66.

Monday, 19*th December* 1864.

SIR DAVID BREWSTER, President, in the Chair.

The President, on taking the Chair, delivered the following Address:—

In taking the Chair, to which, by your kindness, I have been appointed, it may not be an inappropriate introduction to its duties if, in congratulating you on the prosperous state of the Society, I should refer to some facts in its history, not generally known, which have materially contributed to its prosperity and progress.

In the closing years of the last and in the first decade of the present century, the Society was in a very languid condition. In each of the years 1799, 1802, 1803, 1808, and 1809, only one of the papers read at its meetings was published in the Transactions; and in 1801 and 1806, not a single paper read in these years was published.

While our Transactions were thus scantily supplied with papers, those actually read were few in number, and often too abstruse to excite a general interest. The regular meetings of the Society had frequently no other business than to read the minutes, elect members, and receive donations; and this was sometimes done in the presence only of a Secretary and one or two members of Council. Under such circumstances, the Secretary summoned the members by a billet, printed with *red* ink when a paper was to be read, and one in *black* when he had nothing to communicate.

At this time Sir George Mackenzie, Mr Skene, Mr Allan, and myself—then office-bearers or members of Council, made arrangements that a paper of some kind should be read at every meeting, and in this way a more numerous attendance was obtained.

This abnormal process, however, did not continue long. The Huttonian Theory of the Earth, which its distinguished author promulgated in our Transactions for 1785, had attracted the attention of naturalists. Sir James Hall, then a young man, entered with enthusiasm into its study; and so early as 1790 he laid before the Society certain views on the fusion and subsequent crystallisation of mineral substances, which seemed hostile to the opinions of his master. Having proposed to confirm them by experiment, Dr Hutton, as Sir James says, "gave him little encouragement;" and, under the influence of a false delicacy, he abstained from prosecuting the subject during the life of his friend. In 1798, however, after Dr Hutton's death, he resumed and published his experiments on the fusion of whinstone and lava; and was led to those admirable researches "on the effects of compression in modifying the action of heat," which he communicated to the Society, and published in 1805.

This remarkable paper having removed many of the objections which had been urged against the Huttonian theory, it was eagerly embraced and defended by Professor Playfair, Lord Webb Seymour, Sir George Mackenzie, Mr Allan, Dr Hope, and other geologists. Professor Jameson had about this time returned from Freyberg, imbued with all the doctrines of the Wernerian School, and eager to propagate them among his pupils and friends. Dr Thomas Thomson and Dr Macknight joined his standard; and the rival theories of fire and water were discussed in this Society with all the warmth, I may even say the bitterness, of political or theological controversy. Vanquished by the superior science of their opponents, the Wernerians quitted the field, and the Huttonian theory, illustrated by the eloquence of Professor Playfair, attracted to its study the most distinguished geologists of other lands, and took a high place among the natural sciences.

Several English geologists were thus led to establish the Geological Society of London; and though, with the view of disarming the prejudices which had been excited against the Huttonian doctrines they resolved only "to collect the materials for future generalisations," yet the great truths which had been established in Scotland were soon accepted and confirmed by the most eminent of their number.

If our Society gained in popularity, and increased in numbers, during the controversy to which I have referred, it suffered a serious loss by the retirement of Professor Jameson and his friends to the Wernerian Society which he had established in 1808. But what was a loss to us was a gain to science. The new Society enlisted in its service a number of young and active naturalists, who enriched its Transactions with many papers of great interest and value.

If geology, as a science, drew its first breath within our walls, by the active labours of our colleagues, the kindred science of mineralogy was, at the same time, earnestly studied and greatly advanced. Mr Thomas Allan, who possessed one of the finest collections in Scotland, spared no expense in enriching it with new and rare minerals. In 1808, a Danish vessel, brought into Leith as a prize, was found to contain a small collection of minerals, which was purchased by Mr Allan, and Colonel Imrie, a Fellow of this Society, and a contributor to its Transactions. Among these minerals they found a large quantity of cryolite, a substance so rare that at the market price it would have brought L.5000. They found also crystals of gadolinite, sodalite, and a new mineral, to which Dr Thomson, who analysed it, gave the name of Allanite.

These interesting minerals had been collected in Greenland by Mr (afterwards Sir Charles) Giesecké, during the mineralogical survey which he had made of that country between 1805 and 1813, and were shipped by him for Copenhagen in 1808. Upon his arrival at Hull in 1813, with another and a more valuable collection, he learned the fate of his former specimens, and immediately proceeded to Edinburgh, where he was hospitably received by Mr Allan, Sir George Mackenzie, and other members of this Society. During his residence here he contributed papers to our Transactions, and acquired so high a reputation as a mineralogist, that, through the interest of his friends here, he was appointed to the Chair of Mineralogy in the Royal Dublin Society.

While the study of mineralogy was thus greatly promoted by the labours and liberality of Mr Allan, he had the good fortune, at a later period, to bring to Edinburgh, and receive under his roof for nearly four years, a young German mineralogist of very uncommon acquirements. William Haidinger, a native of Vienna, who had studied mineralogy at Gratz under the celebrated Frederick Mohs, came to Edinburgh in 1823, and resided with Mr Allan till 1826, when he returned to Austria, where he prosecuted with ardour his geological and mineralogical studies, and where he now occupies a high place in the scientific institutions of Vienna.

During his residence in Edinburgh, he published several valuable papers in our Transactions, and delivered a course of lectures on crystallography, at which Dr Edward Turner and other two friends were the audience. In claiming to have been one of his pupils at these lectures, I cannot resist the gratification of claiming him as a pupil in that branch of optics, connected with mineralogy, which was then ardently studied in every part of Europe. When Mr Haidinger returned to Vienna, he prosecuted the study of physical optics with great zeal and success, and had the good fortune to discover one of the most beautiful facts in that branch of science. He was the first who observed that curious property of the eye by which it discovers polarised light, and even the plane of its polarisation, without any instrument whatever. The cause of this remarkable phenomenon, called "Haidinger's brushes," has not been discovered; but there is reason to believe that it is produced by a structure in the retina, immediately behind the *foramen centrale.*

Although the financial state of the Society was greatly improved by the increase in the number of its members, yet its funds were quite inadequate to defray the necessary expenses of such an institution. The annual grant, therefore, of L.300, given in 1836 by the Government of Lord Melbourne, though it enabled the Society to pay the rent of its apartments, left nothing for those special objects which such institutions are expected to promote. When we consider that the Royal Society of London has an annual grant of L.1000, with free apartments in Burlington House, and a sum for the royal medals, we can hardly doubt that an earnest representation to the Government would obtain for us a similar, though, doubtless, a smaller grant.

One of the most effective means by which a society like ours can promote the interests of science, is the adjudication of prizes to its successful cultivators. The first bequest to us for this purpose was made by the late Mr Keith of Ravelston (long an office-bearer, and occasionally a contributor to our Transactions), who left L.600 to found a biennial prize "for the most important discovery in science made in any part of the world, but communicated by its author to the Royal Society of Edinburgh, and published in its Transactions."

In 1855, Sir Thomas Macdougall Brisbane, when President of the Society, gave L.400 to found a biennial prize of L.30 to promote any branch of science to which the President and Council might devote it; and in the following year Dr Patrick Neill bequeathed L.500 to found a biennial or triennal prize, to be adjudicated to the most distinguished Scottish naturalist. These prizes have been gained by some individuals not Fellows of the Society, and have procured for our Transactions many valuable communications which they would not otherwise have obtained.

Unwilling to allow their prizes to remain unappropriated, it has been the practice of some societies to adjudicate them occasionally, contrary to the conditions imposed by the deed of foundation. Such a proceeding cannot be too carefully avoided. It is injurious to the society, by preventing the accumulation of the fund. It is unjust to future competitors, who would otherwise have received a richer prize. It diminishes the importance of the prize by its too frequent adjudication; and it prevents the wealthy patrons of science from intrusting money to an institution that does not respect the conditions upon which it is given.

In calling your attention to some of the leading features in the history of the Society, I cannot avoid expressing the regret which has been very generally felt at the discontinuance of those biographical memoirs of distinguished members, which, during the secretaryship of Professor Playfair, formed such an interesting portion of our Transactions. I take to myself some blame, that when I held the same office, no memoir of Dugald Stewart, Professor Playfair, and Sir James Hall should have been communicated to the Society; and the only apology I can offer is, that the researches in which I was engaged were too engrossing to admit of any other occupation. The evil, however, may yet be remedied, and, as suggested by a former Council, the Macdougall Brisbane prize might be given for important memoirs, such as that of Professor Ferguson, by Mr Small, which has been published in our Transactions.

In calling your attention to the controversy between the Huttonian and Wernerian geologists, as an epoch in the history of the Society, I referred to the prejudices which it awakened, and the bitterness with which it was carried on. The formula of Dr Hutton, that "in the natural history of the earth there was no vestige of a beginning, and no prospect of an end," alarmed the timid, and furnished his opponents with a weapon which philosophers should disdain to wield. Dr Hutton observed, "that the Mosaic history placed the beginning of man at no great distance, and that there had not been found in natural history any document by which a high antiquity might be attributed to the human race." He held no opinions and indulged in no speculations incompatible with revealed truth, and his Scottish disciples, led by Professor Playfair, maintained the doctrines of their master without doing violence to the serious convictions of their countrymen.

It was reserved for another school of geology to array the wisdom of this world—Science falsely so called—against truths eternal and immutable. It was reserved for an unscrupulous philosophy to hold an inquest on the origin of that life which God breathed into man to make him a living soul,—to teach the heresy of the creation and government of the universe by law; thus hurling the Almighty from His throne,—Himself but the first link of the chain of life,—the sovereign of an empire without a sceptre,—the Father of a family, blind to the tears, and deaf to the cries of his children.

Such views of the Divine Government will, I trust, never find acceptance within these walls. In the study of nature there is no forbidden ground. Into its deepest mysteries we are invited to dive, and if we make Reason our guide, and Imagination our footstool, we may rest assured that truths that are demonstrated will never rush into collision with truths that are revealed.

1. On Variability in Human Structure, with illustrations from the Flexor Muscles of the Fingers and Toes. By William Turner, M.B. (Lond.), Demonstrator of Anatomy in the University.

The author, after referring to variations in the external form of the body in different individuals, and to the relations between external form and internal structure, proceeded to discuss the subject of variability in the different organic systems. He showed that internal structural variations conferred upon the individual characters as distinctive as any peculiarities in external configuration. It was argued that in the development of the individual a morphological specialisation occurs, both in internal structure and external form, so that each man's structural individuality is an expression of the sum of the individual variations of all the constituent parts of his frame.

The muscular system was adduced as affording abundant illustration of the specialisation of structure in the individual, and an analysis was given of a number of dissections of the flexor muscles of the fingers and toes. In the long flexors of the thumb and fingers, not only were variations in bulk, extent of attachment, and mode of division described, but the frequent existence and variously modified arrangements of bands connecting together not only the muscles, or divisions of muscles, situated on the same plane, but those situated on different planes were pointed out. A close analysis of the arrangements of the flexor hallucis longus, flexor longus digitorum, flexor accessorius, flexor brevis digitorum, and lumbricales, in thirty dissected feet, was then given, and the extent of variation which these specimens exhibited detailed at considerable length. The necessity of dissecting carefully the soft parts in the different races of men, so as to study the amount of variation which might occur in them, was insisted on in the paper.

2. On the Principle of Onomatopoeia in Language. By Professor Blackie.

Professor Blackie read a paper on Onomatopoeia, or the influence of the imitative principle on the formation of language. Without denying that a number of words in the later development of language were purely notional, that is, intended to represent an idea, not to imitate a sound, he strongly contended, that the whole original stock of language was either direct imitations of natural sounds, or analogical representations of things visible and tangible by things audible. As proofs of this he adduced various illustrations from the Aryan and the Semitic languages. He showed specially that most motions are accompanied by certain sounds or noises, and these sounds are imitated more or less perfectly by the great family of verbs which express motion in all languages; that objects which are sharp or blunt, rough or smooth to touch, are expressed by words which have the same character to the organs of speech and to the ear; and that there is a distinct correlation between all outward sensuous impressions and the emotions thereby excited in our minds and nervous system, which necessarily causes the vocal expression of any feeling to bear a likeness to the external impression from which it proceeded. He did not consider the scientific truth of this matter to be in any way affected by the vexed question, whether man was created originally an infant or full-grown; and the disownment of the imitative principle in the formation of language by Professor Max Müller, in his recent work on the science of language, he considered as the result of a German prejudice against even the appearance of sensationalism, a fondness for the abstract in preference to the concrete in philosophy, and a delight in the mysterious.

3. Note on the Phlogistic Theory. By Alexander Crum Brown, M.D., &c.

When we consider that the Phlogistic Theory formed, as it were, the central point round which the facts of chemistry first crystallized into regular scientific form, and that for more than a hundred years it was recognised by all as the foundation of the science, we might reasonably suppose that it should contain at least some germ of truth.

I think I shall be able to show in the following note that not only is this the case, but that the theory itself, as stated by its founders, Beccher and Stahl, is, if not strictly true, a very close approximation to what we now recognise as truth.

According to Stahl, all combustibles contain one and the same substance in different proportions, according to the degree of their combustibility. That substance is phlogiston; and when a combustible is burnt, or a metal calcined, its phlogiston is given out. When charcoal or oil is heated with a metallic calx, the phlogiston leaves the former, and is found in combination in the metallic regulus.

Now, if we consider the facts of the case in an unprejudiced way, we must admit that a combustible loses something when it is burnt, it loses combustibility, or the capability of being burnt. In the same way, in the preparation of phosphorus, or the reduction of a metallic calx, the charcoal loses this capability, while the phosphorus or metal acquires it.

The capability of being burnt is essentially the power of emitting a certain quantity of heat, and, as we know from the researches of Rumford, Davy, and others, and from the later and more accurate determinations of Joule, that heat is a particular form of what has been called kinetic energy, we can have no difficulty in admitting that the power of emitting a certain quantity of heat is a particular form of potential energy.

If, in the statement of the phlogistic theory, we read potential energy for phlogiston, and understand that when phlogiston is separated from one body and not taken up by another, as in combustion, this potential energy is converted into kinetic energy, we have a tolerably complete account of what we now know of the matter.

Whether we choose, with Beccher and Stahl, to call phlogiston a substance or not, depends on our definition of what a substance is, If we restrict that name to ponderable matter, of course it is not a substance, but when we consider that energy is as indestructible as matter, that we can trace it through its various combinations and double decompositions, and that we are in a fair way to discover, not, indeed, its atomic weight, for it has none, but its chemical unit, it does not seem very absurd or unreasonable to class it along with the ordinary chemical elements.

It may be objected to the phlogistic theory, as thus explained, that it is not the combustible alone, but the combustible and oxygen, that have potential energy, and that it is only when the two unite that this potential energy is transformed into kinetic. This objection is equally valid against the statement, that a clock, when wound up, contains potential energy, it is not the clock, but the clock and the earth, which contain this, and it is transformed when the clock weight and the earth approach each other.

In fact, energy is not conceivable without a system of at least two bodies.

We must, of course, recollect that the phlogistic chemists were ignorant of the existence and nature of oxygen, and it is to this ignorance that we must ascribe the downfall of the theory of phlogiston. They attempted to explain, by means of this theory, facts (such as the increase of the weight of a combustible when burnt) depending on a totally different cause. They were thus led to modify the theory, and ascribe to phlogiston negative weight, and to identify it sometimes with carbon and sometimes with hydrogen gas.

It is not surprising that the theory, thus mutilated, should have been overthrown, and we have only to regret that the valuable truth embodied in it should have been lost sight of; that the antiphlogistic chemists, like other reformers, destroyed so much of what was good in the old system, and that, in consequence of this, we are only now beginning to see what was obvious to such a man as Stahl, that oxide of iron does not contain metallic iron; that no compound contains the substances from which it is produced, but that it contains them minus something. We now know what this something is, and can give it the more appropriate name of potential energy; but there can be no doubt that this is what the chemists of the seventeenth century meant when they spoke of phlogiston.

The following Donations to the Library were announced:—

Transactions of the Linnean Society, London. Vol. XXIV. Part 3. 4to.—*From the Society.*

Journal of the Linnean Society, London. Vol. VIII. No. 31 (Botany). 8vo.—*From the Society.*

List of the Linnean Society, London. 1864. 8vo.—*From the Society.*

Proceedings of the Royal Society of London. Vol. XIII. No. 69. 8vo.—*From the Society.*

Proceedings of the Royal Institution of Great Britain. Vol. IV. Parts 3 and 4. 8vo.—*From the Institution.*

Journal of the Asiatic Society of Bengal. No. 3. 1864. 8vo.—*From the Society.*

Transactions of the Royal Medical and Chirurgical Society of London. Vol. XLVII. 8vo.—*From the Society.*

Transactions of the Historic Society of Lancashire and Cheshire. New Series. Vol. III. 8vo.—*From the Society.*

Journal of the Royal Geographical Society. Vol. XXXIII. 8vo. —*From the Society.*

Thirty-seventh Annual Report of the Council of the Royal Scottish Academy. 1864. 8vo.—*From the Academy.*

The Design and Construction of Harbours. By Thomas Stevenson, F.R.S.E. 8vo.—*From the Author.*

Memoirs of the Royal Astronomical Society. Vol. XXXII. 4to. —*From the Society.*

Transactions of the Royal Scottish Society of Arts. Vol. VI. Part 4. 8vo.—*From the Society.*

Quarterly Return of Births, Deaths, and Marriages registered in the Divisions, Counties, and Districts of Scotland, for the Quarter ending 30th September 1864. 8vo.—*From the Registrar-General.*

Monthly Returns of Births, Deaths, and Marriages registered in the Eight Principal Towns in Scotland—September, October, and November 1864. 8vo.—*From the Registrar-General.*

Monthly Notices of the Royal Astronomical Society, November 1864. 8vo.—*From the Society.*

Entoptics—Letter to Dr Iago from Dr Mackenzie. 1864. 8vo. —*From the Author.*

On the Distribution of Rain over the British Isles during the years 1860–63. By G. I. Symons. 8vo.—*From the Author.*

Proceedings of the Geologist's Association. 1863–64. 8vo.—*From the Association.*

On the Wet Dock and other Works about to be constructed by the Commissioners for the Harbour and Docks of Leith. By George Robertson, F.R.S.E., &c. 8vo.—*From the Author.*

Geometrical Disquisitions. By Lawrence S. Benson of South Carolina. 8vo.—*From the Author.*

On the Circle-Area and Heptagon-Chord. By S. M. Drach, F.R.A.S. 8vo.—*From the Author.*

Journal of the Geological Society of Dublin. Vol. X. Part 2. 8vo.—*From the Society.*

Journal of the Chemical Society of London. New Series. Vol. II. 8vo.—*From the Society.*

Report read by the Astronomer-Royal for Scotland to the Special Meeting of Her Majesty's Government Board of Visitors of the Royal Observatory, Edinburgh, on the 4th, and issued on the 11th November 1864. 4to.—*From the Author.*

Bulletin de la Société de Géographie, Paris. Tome VII. 8vo.—*From the Society.*

Bulletins de l'Académie Royale de Belgique. 2^{me} Sér. Tomes XV.-XVII. 8vo.—*From the Academy.*

Mémoires Couronnés et autres Mémoires publiés par l'Académie Royale de Belgique. Tomes XV., XVI. 8vo.—*From the Academy.*

Annales de l'Observatoire Physique Central de Russie, publiées par ordre de sa Majesté Impériale. Par A. T. Kupffer. 1860, 1861. St Petersburg. 4to.—*From the Observatory.*

Mémoires de l'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique. Tome XXXIV. 4to.—*From the Academy.*

Mémoires Couronnés et Mémoires des Savans Etrangers, publiés par l'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique. Tome XXXI. 4to.—*From the Academy.*

Nova Acta Regiæ Societatis Scientiarum Upsaliensis. Vol. V. Fasc. 1. 4to.—*From the Society.*

Annales de l'Observatoire Royal de Bruxelles. Tome XVI. 4to. —*From the Observatory.*

Annuaire de l'Observatoire Royal de Bruxelles. 1864. 16mo.—*From the Observatory.*

Glossaria Linguarum Brasiliensium, Glossarios de diversas lingoas e dialectos que fallao os Indios no Imperio do Brazil. Von Dr Carl F. Phil. von Martius. Erlangen, 1863. 8vo.—*From the Author.*

Compte-Rendu de la Commission Impériale Archéologique pour l'année 1862. With Atlas. St Petersburg. 4to.—*From the Russian Government.*

Annuaire de l'Académie Royale des Sciences de Belgique. 1864. 16mo.—*From the Academy.*

L'Homme Fossile des Cavernes de Tombrive et de Therm, avec une Introduction Historique et Critique. Par J. B. Rames, F. Garrigon, et H. Filhol. 1862. 8vo.—*From the Authors.*

Etude Chimique et Medicale des Eaux Sulfureuses d'Ax (Ariége), précédée d'une Notice Historique sur cette Ville, et suivie de l'Analyse des Sources Sulfureuses Chaudes de Méreus. Par Felix Garrigon. 1862. 8vo.—*From the Author.*

Lettre à M. le Professeur N. Joly, présentée par lui à l'Académie des Sciences de Toulouse. Par le Docteur F. Garrigon. 1862. 8vo.—*From the Author.*

Mémoire sur les Cavernes de Therm et de Bonicheta (Ariége). Par le Docteur Felix Garrigon de Tarascon (Ariége). 8vo. *From the Author.*

L'Age de le Pierre dans les Cavernes de la Vallée de Tarascon (Ariége). Par MM. F. Garrigon et H. Filhol. 8vo.—*From the Authors.*

Note sur Deux Fragments de Machoires humaines trouvés dans la Caverne de Bruniquel (Tarn-et-Garonne). Par MM. F. Garrigon, L. Martin, et E. Trutal. 4to.—*From the Authors.*

Tableau des Donnés Numériques qui fixent 159 Cercles du Réseau Pentagonal. Par M. L. Elie de Beaumont. Paris, 1863. 4to. —*From the Author.*

Considérations sur la Prévision des Tempêtes, et spécialement sur celles du 1 au 4 Decembre 1863. Par Ferdinand Muller. 4to.—*From the Author.*

Bulletin de l'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique. Tome XVIII. Nos. 9, 10, 11. 8vo. —*From the Academy.*

Statistique et Astronomie—Sur la Mortalité pendant la Première Enfance. Par M. Ad. Quetelet. 8vo.—*From the Author.*

Sur le Cinquième Congrès de Statistique tenu à Berlin du 4 au 12 Septembre 1863. Par M. Ad. Quetelet. 8vo.—*From the Author.*

Phénomènes Périodiques—Des Phénomènes Périodiques en général. Par M. Ad. Quetelet. 8vo.—*From the Author.*

Notice sur la Périodicité des Etoiles Filantes du mois de Novembre. Par M. Ad. Quetelet. 8vo.—*From the Author.*

Sur les Etoiles Filantes et leurs lieux d'Apparition. Par MM. Ad. Quetelet, Le Verrier, Haidinger, et Poey. 8vo.—*From the Authors.*

Physique du Globe—Etoiles Filantes; Aérolithe et Ouragan en Decembre 1863. Par M. Ad. Quetelet. 8vo.—*From the Author.*

Etoiles Filantes de la Période du 10 Août 1863. Par M. Ad. Quetelet. 8vo.—*From the Author.*

Orage du 10 Septembre 1863, observé à Bruxelles. Par M. Ernest Quetelet. 8vo.—*From the Author.*

Résumé des Observations sur la Météorologie et sur le Magnétisme Terrestre. Par M. Ad. Quetelet. 4to.—*From the Author.*

Physique du Globe. Mémoire sur les relations qui existent entre les Etoiles Filantes les balides et les essaims de Météorites. Par M. Haidinger, de Vienne. 8vo.—*From the Author.*

Memorie del Nuovo Osservatorio del Collegio Romano D. C. D. G. dall' Aprile 1856 al Settembre 1857. Pubblicate dal Direttore P. A. Secchi, D.C. D.G. 4to.—*From the Observatory.*

Memorie dell' Osservatorio del Collegio Romano D.C. D.G. Nueva Serie, 1857-59, 1860-63. Pubblicate dal P. A. Secchi. 4to.—*From the Observatory.*

Bullettino Meteorologico dell' Osservatorio del Collegio Romano con Corrispondenza e Bibliografia per l'Avanzamento della Fisica Terrestre, compilato dal P. A. Secchi, D.C. D.G. 4to. —*From the Observatory.*

Misura della Base Trigonometrica eseginta sulla Via Appia, per ordine del Governo Pontificio nel 1854-55. Dal P. A. Secchi, D.C. D.G. 4to.—*From the Observatory.*

Sur le Mouvements propre de quelques Etoiles. Par Ern. Quetelet. 4to.—*From the Author.*

Compte-Rendu Annuel adressé à S. Exc. M. de Reutern, Ministre des Finances, par le Directeur de l'Observatoire Physique Central, A. T. Kupffer, 1861-62. 4o.—*From the Author.*

Schriften der Universität zu Kiel aus dem Jahre 1863. Band X. 4to—*From the University.*

Preussische Statistik die Witterungserscheinungen des Nördlichen Deutschlands in Zietraum von 1858-63. Von H. W. Dove. 4to.—*From the Author.*

Tuesday, 3d January 1865.

PROFESSOR CHRISTISON, V.P., in the Chair.

The Chairman delivered the Makdougall-Brisbane Medal, which had been awarded to Mr J. Denis Macdonald, R.N.

The following Communications were read :—

1. A Map of Taranaki, New Zealand, executed by a Maori, was exhibited, and remarks on it by Dr Lauder Lindsay were communicated by Mr A. Keith Johnston.

2. Professor Tait read a note on the various investigations of the Law of Frequency of Error; in which he pointed out that the difficulty was really a logical, not an analytical one; and showed how from *à priori* principles, somewhat different from those of Laplace, it was easy to obtain the received result without the formidable analysis of Laplace and Poisson. Some curious consequences were shown to follow from the principles adopted.

3. Notice respecting Mr Reilly's Topographical Survey of the Chain of Mont Blanc. By Principal Forbes.

On the 6th February 1843, or almost twenty-two years ago, I had the honour of laying before this Society an account of a topographical survey of the Mer de Glace of Chamouni and its neighbourhood, together with the detailed map founded upon it, being probably the first map of a glacier on such a scale ever constructed. Since that time I have never ceased to interest myself in the improvement and extension of this survey. Two subsequent editions of the map appeared, containing the results of my continued observations with the theodolite in 1843, 1844, 1846, and 1850. The last edition (on a reduced scale), in 1853, included the whole of the glacier of Bossons and the results of an extended triangulation, in which the Flegère and the Breven formed the extremities of a new base connected with the stations L, M, and I of my former survey.

Since 1851 the state of my health has put a bar in the way of any farther personal exertions in elucidating the topography of the chain of Mont Blanc. But as opportunity served, I have not ceased to urge the younger generation of Alpine travellers to extend our knowledge of its details, and, by making the theodolite their companion, and multiplying panoramic views of all intricate mountain groups, to obtain valuable topographical knowledge, at the same time that they enjoy the luxury of Alpine rambling. The south-western part of the chain of Mont Blanc, which really was very much a *terra incognita* as to its interior conformation (though perpetually visited on its outskirts by all who passed the Col du Bonhomme), was partially explored and sketched by Mr Tuckett, an active member of the Alpine Club; but the district to the east of the Mer de Glace, stretching towards the Col de Balme and the Swiss Val Ferret, remained a complete enigma, the intricacy and obscurity of which appeared more and more as its recesses were successively invaded by the adventurous inroads of members of the Alpine Club. For years I had been urging my mountaineering friends to carry a theodolite to the summit to the east of the Jardin, marked in my map as "Nameless Peak A," from whence I knew that the debatable land to the eastward would probably be overlooked; but it was not attempted till 1863. The year before, Sheet xxii. of the Swiss Federal Survey had been issued, and was looked for with great interest by myself and others as likely to clear up at least a part of the mystery of this Gordian knot of peaks and glaciers. So far as it was included within the rigorous limits of the Swiss Confederation, it was as completely satisfactory as that survey has everywhere else been acknowledged to be. But the Federal boundary once passed, it was evident that the topography of the adjacent part of Savoy included in the Swiss sheet was far less reliable, if indeed worthy of any confidence at all. The persuasion of the uncertain state of the geography of this interesting portion of the most important mountain group in Europe was common to myself and others who had visited or crossed that part of the chain. Early in 1863 I had the good fortune to make the acquaintance of Mr Reilly, who was already interested in the problem, and who shewed me panoramic drawings of different parts of the range, executed with remarkable facility and correctness. He readily agreed to return to the spot and take a theodolite with him. The map which I now have his permission to exhibit to the Society is the result of his labours in 1863, with some corrections and additions in 1864. It starts fundamentally as a base with my triangulation of the Flegère and Breven stations, and thus connects itself immediately and accurately with the whole of my map so far as it extended, that is, from the top of Mont Blanc to the "Nameless Peak A," parallel to the chain, and from the Jorasses to the Flegère in a perpendicular direction. Mr Reilly carried forward the main triangulation up the valley of the Arve to the Col de Balme, and thence to the very recesses of the Glacier du Tour, which was the seat of at least one part of the "Gordian knot" already referred to. He gradually found himself led to the conclusion that the Sardinian surveyors, on whose authority the Swiss map beyond the limits of the Confederation was probably constructed, had made a mistake of an almost incredible kind, representing *one and the same mountain* under the names of *Aiguille d'Argentière* and *Pointe des Plines* in *two* different places a mile and a-half apart, and separated by a vast ice-field communicating with the Glacier du Tour, which ice-field has of course no existence, as the two mountains, by which it was represented as being bounded, are, as already stated, absolutely identical. The portion of glacier thus annihilated was represented as two and a quarter English miles in length. Mr Reilly, whose activity as a pedestrian is equal to his skill as a draughtsman, put the seal on his topographical discovery by passing for the first time the elevated col between the Aiguilles of Argentière and Chardonnet, starting from the side of the glacier of Argentière. Had existing maps been correct, he would have alighted on the glacier of Tour within the frontier of Savoy; but in effect he found himself on the glacier of Salena in Swiss territory.

The western portion of the chain of Mont Blanc next engaged his attention. He was enabled by his extraordinary activity, and his skill in mountain drawing, to lay down with an accuracy far beyond any thing previously attained in that quarter, the whole western and southern faces of the chain, with the numerous vast glaciers which intersect these. On the whole, the position of about 200 points was fixed by the theodolite, the position of one or two fundamental stations (especially of Mont Joli) having been obtained from the French engineers.

In the summer of 1864, Mr Reilly revisited the chain of Mont Blanc with his map and theodolite, and was able to improve the former at several points formerly obscure, particularly in the neighbourhood of the southern glacier of Miage. He gained great additional insight into the details of the very heart of the wildest parts of the range by ascending, all for the first time, three lofty peaks previously unattained, the Aiguille d'Argentière and the Mondelant to the eastward, and the magnificent Aiguille de Trelatête, which closely approaches Mont Blanc on the south-west. In addition to this, he traversed this most difficult chain in two new directions from the Jardin to the Glacier of Triolet on the Italian side, and again from the Col de Miage to the glacier of Bossons by the Dôme de Gouté.

Altogether, Mr Reilly has achieved the remarkable distinction of presenting for the first time to the eye of the tourist and the physical geographer a correct and skilful delineation of the most remarkable and most elevated mountain chain in Europe. Three different states, France, Sardinia, and Switzerland, divide the chain between them. Of these, Switzerland alone has given anything to the world in the least degree worthy of the spot, and that unfortunately only embraces a secondary part. It is a singular chance which has enabled a British amateur to produce a work so creditable and so long desired. Let us hope that no delay will take place in its publication.

4. On the Solution of Perigal's Problem concerning the contact of Epicycloidal Curves. By E. Sang, Esq.

If the centre of a revolving wheel be carried with a uniform velocity, along a line; and if a tracing-point be fixed to an arm of the wheel, that point will trace out a curved line; to which the general name *cycloid* or *trochoid* has been given; the former appellation being often restricted to those cases in which the centre of the wheel moves in a straight line, while the name *epicycloid* is given when the same centre moves along the circumference of a circle.

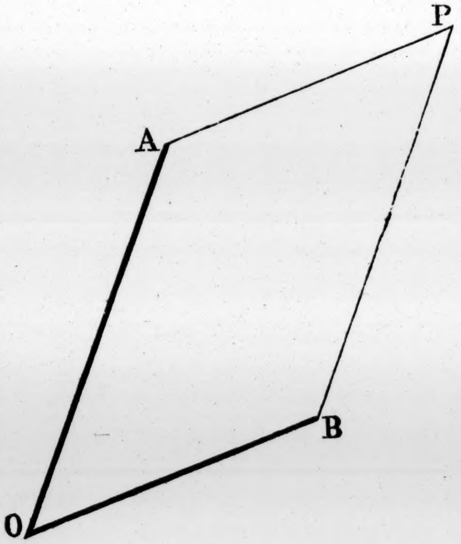
When the tracing-point is placed very close to the centre of the wheel, the curve is slightly undulated; the depth of the waves, other things remaining the same, increases with the distance of the tracing-point from the centre. As that distance is augmented the curve at last becomes cusped as in the common cycloid traced by a nail in the tire of a cart wheel. If the distance of the tracing-point be still farther augmented, the cycloid becomes looped; the loops become wider, and come each to touch that loop adjacent to it on either side.

Mr Perigal's problem is, to determine the conditions under which this contact of the loops takes place.

If the arm of the revolving wheel be still farther lengthened, the loops come to touch those removed from them by two, by three, or by any number of steps, so that the problem may admit of many solutions.

Mr Perigal has obtained the solution of this problem in a considerable variety of cases, by help of mechanical appliances, and has exhibited them in his beautiful series of machine-engraved epicycloids, or bi-circloids, as he calls them.

The most comprehensive view of the genesis of epicycloidal curves is obtained by supposing two arms, OA and OB, to turn with uniform velocities on a common centre O, just as do the two hands of a watch, and by supposing the rhomboid OAPB completed at each instant; the point P then traces an epicycloid.



If the angular velocities of the two arms be represented by α and β, while the lengths are A and B, the directions of these arms at any instant of time t, are represented by αt and βt. It is shown that if T be the time corresponding to the contact of one loop with another, we must have the proportions

$$\alpha : \beta :: \tan \alpha T : \tan \beta T$$
$$A : B :: \sin \beta T : \sin \alpha T$$

so that the solution of the problem resolves itself into that of this trigonometrical question, "*To find two circular arcs in a given ratio and of which the tangents are in the same ratio.*"

The solution of this question, again, resolves itself into that of algebraic equations of the order $\frac{1}{2}(\alpha+\beta-3)$ or $\frac{1}{2}(\alpha+\beta-4)$, when α and β are represented by integer numbers prime to each other. A table of the solutions for all possible values of α and β up to *ten* is given; and it is remarkable that these solutions apply whether the motions of the two arms be in the same or in opposite directions.

The problem is then extended to the case of the common cycloid in which the centre of the revolving wheel moves along a straight line. Here it is shown that we have to discover those arcs which are equal in length to their own tangents; and that the revolving arm must be made proportional to the secants of these arcs. A table of the first ten solutions is appended to the paper.

The following Gentlemen were duly elected Ordinary Fellows of the Society.

ALFRED R. CATTON, B.A.
REV. FRANCIS REDFORD, M.A.

The following Donations to the Library were laid on the table.

Descriptive Catalogue of the Pathological Specimens, contained in the Museum of the Royal College of Surgeons of England. London. Supplement II. 4to.—*From the Council of the College.*

The Stereoscope, its History, Theory, and Construction, with its application to the Fine and Useful Arts, and to Education. By Sir David Brewster, K.H., D.C.L., &c. London, 1856. 8vo. —*From the Author.*

The Kaleidoscope, its History, Theory, and Construction, with its application to the Fine and Useful Arts. By Sir David Brewster, K.H., D.C.L., &c. Second Edition. London, 1858. 8vo.—*From the Author.*

A Treatise on New Philosophical Instruments for various purposes in Arts and Sciences, with Experiments on Light and Colour.

By David Brewster, LL.D. 2 Vols. Edinburgh, 1813. 8vo.—*From the Author.*

Photo-Lithographic Impressions of Traces produced simultaneously by the Self-recording Magnetographs at Kew and Lisbon (Atlas).—*From the Royal Society, London.*

Proceedings of the British Meteorological Society. London. Vol. II. No. 15. 8vo.—*From the Society.*

The Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. Edinburgh. No. 87. January 1865.—*From the Society.*

The Canadian Journal of Industry, Science, and Art. Toronto. New Series, Nos. 53, 54. 8vo.—*From the Canadian Institute.*

Sveriges Geologiska Undersökning pa Offentlig Bekostnad Utförd under Ledning. Af A. Erdmann. Nos. 6–13. Stockholm. 8vo. With Atlas.—*From the Author.*

Rendiconto della Reale Accademia di Archeologia, Lettere e Belle Arti. Napoli. Anno 1864. 4to.—*From the Academy.*

Sitzungsberichte der Königl. bayer. Akademie der Wissenschaften zu München. Hefte I. III. V. 8vo.—*From the Academy.*

Rede gehalten in der Festsitzung der könig. Akademie der Wissenschaften zu München am 30 Marz 1864. Von T. v. Dollinger. 8vo.—*From the Author.*

Uebersichten der Witterung in Oesterreich und Einigens auswärtigen Stationen im Jahre 1859. Zusammengestellt von C. Laurent. Wien, 1861. 4to.—*From the Author.*

Monday, 16th January 1865.

SIR DAVID BREWSTER, President, in the Chair.

The following Communications were read:—

1. Exhibition of Three Skulls of the Gorilla, received from M. Du Chaillu, with Observations relative to their Anatomical Features. By Dr Burt and Mr W. Turner.

After placing on the table a series of three crania of the gorilla (*Troglodytes gorilla*), which he had a short time ago received from

M. Du Chaillu, Dr Burt proceeded to relate to the Society several facts, recently come to light, in support of various of the statements of that traveller which had been called in question. He alluded to the doubts which had been cast on several of the statements of M. Du Chaillu, and to the uncourteous treatment he had received at the hands of some of his detractors, and enumerated some of the proofs since produced by that gentleman, which are now to be found in the British Museum, and in the possession of men of distinction in science, illustrative of the natural history and the habits of the people of Equatorial Africa, which confirmed the veracity of that gentleman's observations. The last letters received from M. Du Chaillu were written from Fernand Vaz previous to his departure for the interior.

In giving an account of the anatomical features of the crania which Dr Burt had entrusted to him for examination, Mr Turner stated, that as the elaborate memoirs of Professor Owen, Dr Wyman, MM. Duvernoy and I. G. St Hilaire, were within the reach of every comparative anatomist, it was needless for him to go into any detailed description of the characters of the skull of the gorilla. But as the crania were those of an adult male, an adult female, and a young female, it might be interesting to record the specific and sexual characters, and the differences between the young and adult forms, and so assist in establishing the relative constancy and variability of some of the most important anatomical features. The skulls of an adult male and female, and a younger chimpanzee (*Troglodytes niger*), were at the same time exhibited, and compared with those of the gorilla.* The description, unless when otherwise stated, applied to crania personally examined.

In size, the skulls of the adult male and female gorilla were larger than those of the corresponding sex in the chimpanzee, and the adult female gorilla was larger than the adult male chimpanzee.

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* The crania of the adult male and younger chimpanzee are in the Anatomical Museum of the University; that of the adult female is in the possession of Dr John Alexander Smith. In the adult and apparently aged chimpanzee crania the sutures were all ossified. In the younger animal, although all the permanent teeth had erupted, yet the sutures of the cranial vault were unossified, and the basi-cranial synchondrosis, though ossified, had its position marked by a transverse bony ridge.

The massiveness of the supra- and inter-orbital ridges, and their greater size even in the female gorilla than in the male chimpanzee, and the influence which their great elevation exercised in concealing the frontal part of the cranial vault, were pointed out: only in the young gorilla, and that very slightly, did the frontal vault come into view, when the skull was looked at from before; in all the three chimpanzee crania the frontal vault could be seen from that point of view. The sagittal and occipital crests were absolutely and relatively larger in the adult male than in the female gorilla. These three massive ridges mounted up and converged at the summit of the posterior end of the cranium. The original bilaterality of the sagittal crest was marked in the male by a median depression in its anterior third, subdividing it into two parallel ridges; and quite at its posterior end it bifurcated, where it became continuous with the two halves of the lambdoidal crest, and when seen from the basal aspect, it seemed like a beak in the centre of the rounded occipital outline. The great projection of the lambdoidal crest rendered the under surface of the occipital bone concave, though it was traversed by strong ridges, evidently for the attachment of powerful muscles. The posterior margin of the foramen magnum was 3½ inches from the posterior end of the sagittal crest. In the female the sagittal crest was very little raised above the surface of the conjoined parietals: the lambdoidal crests were much smaller than in the male gorilla, but larger than in the male chimpanzee; the occipital outline rounded, but with no central projecting beak. In the young gorilla the two temporal ridges did not meet in the middle line: at their point of closest approximation they were one inch apart; hence there was no sagittal crest. The occipital crest was feeble, and was joined somewhat more than one inch to the outer side of the middle line by the faintly-marked temporal ridge. Occipital outline rounded, under surface of the bone convex, approaching in form to that of the chimpanzee; posterior margin of foramen magnum 1·9 inch from centre of the occipital crest. In all the three chimpanzee crania the temporal ridges never coalesced: in the adult male, in which they most closely approximated, their nearest points were upwards of an inch apart.

In the adult male and female gorilla the cranial sutures were almost entirely obliterated. In the young animal they were all very distinct. The ali-sphenoid was pointed superiorly, and separated from the parietal by the articulation of the squamous part of the temporal with the frontal. This arrangement was also traced in the chimpanzee, and seems to be the rule in the crania of these anthropoid apes. In the orang, on the other hand, the articulation of the ali-sphenoid superiorly varied in different specimens. Of four crania examined,—in one the ali-sphenoid on each side articulated with the corresponding parietal; in one a tongue-shaped process of the squamous part of the temporal articulated with the frontal, and cut off the ali-sphenoid from the parietal; whilst in the other two crania, the ali-sphenoid articulated with the parietal on one side of the skull only, for on the other side a tongue-shaped process of the temporal was intercalated between them. In two crania of the gibbon, again, a well-marked articulation existed between the ali-sphenoid and the parietal on both sides of each skull; whilst in a third, on the left side, a narrow tongue of the temporal, reaching the frontal, was intercalated between the ali-sphenoid and the parietal, and on the right side the tongue of the temporal projected into, but not quite across, the ali-sphenoid, so that the latter was still, though slightly, in communication with the parietal. If the tongue of the temporal had passed quite across the ali-sphenoid, then the upper end of this bone would have been cut off, and would have formed a triquetral bone in the temporo-parietal suture. In man, the rule is for the ali-sphenoid to articulate with the anterior inferior angle of the parietal, and thus to cut off the frontal from the squamosal; but exceptions not unfrequently occur, and crania seen by the author were referred to, not only in the Negro, Hottentot, Caffre, Bushman, Sandwich Islander, and Australian races, but also in Hindoos, Ceylonese, and Europeans (French, Scotch), in which a tongue-like process of the squamosal passed between the ali-sphenoid and parietal to articulate with the frontal.*

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* Although it would appear from an examination of a considerable number of crania of old-world monkeys that the rule is in them for a tongue-shaped process of the temporal to articulate with the frontal, and consequently to cut off the ali-sphenoid from the parietal, yet several crania have been noted in which the ali-sphenoid and parietal had a well-marked articulation with each other. Some of these skulls had unfortunately not been named, and it was difficult exactly to identify them; but in a skull of *Semnopithecus entellus*, and in one of *Macacus cynomolgus*, the ali-sphenoid articulated on both sides with

In the young gorilla, the squamous part of the occipital bone curved upwards and forwards for more than one inch beyond the rudimentary occipital crest, and contributed therefore to the formation of the posterior part of the vault of the skull. In the adult animal the whole of this part of the bone was overlaid with the bony growth met with at the junction of the sagittal and occipital crests. The angle formed by the junction of the two sides of the lambdoidal suture was well marked in the young gorilla. In the younger chimpanzee a small fontanelle bone existed at each of the two extremities of the sagittal suture,* the squamous part of the occipital bone scarcely extended above the rudimentary occipital crest, and the lambdoidal suture passed across the back of the head in a line approaching much more closely to the horizontal than in the gorilla. The basi-cranial synchondrosis was ossified in the adult animals, but not in the young gorilla. The zygomatic arches and mastoid processes closely corresponded with the descriptions given by Professor Owen. In the adult male and young gorilla the eustachian process of the petrosal (marked *e* in Owen's figure, plate lxiii.) was little more than a well-marked tubercle; but in the adult female it was prolonged downwards for half an inch as a well-formed styliform process.

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the parietal; and though in two crania of Cynocephali the temporal and frontal articulated, yet in a third, whilst they articulated on the right side, on the left the ali-sphenoid joined the parietal. In crania of the following American monkeys,—Ateles, Cebus, Hapale,—the parietal bone not only articulated with the ali-sphenoid, but with the protuberant malar bone. Various anatomists (Owen, Humphry, &c.) have referred to Negro and Australian crania in which the temporal and frontal articulated. Barnard Davis has also figured an Anglo-Saxon skull from Ozingell, Kent (Crania Britannica, pl. 38), in which the same arrangement occurred. From the number of human crania referred to in the text in which this articulation was seen, it may apparently exist in the skulls of any race as an individual peculiarity. The triquetral bone, not unfrequently met with in the sphenoido-parietal suture by separating these bones from each other, may be regarded as an approximation to this arrangement. The occasional occurrence, therefore, of the articulation of the frontal with the squamous part of the temporal bone in human skulls, and the extent of variation the ali-sphenoidal articulation exhibits in the crania of apes, gives to this feature but little value in the discrimination of the diagnostic characters between the crania of men and monkeys.

* Dr Traill and Professor Owen observed in each of the crania of three young chimpanzees, at the posterior end of the sagittal suture, an *os triquetrum.*

The anterior nostrils in the gorilla in form approached a four-sided figure, with the angles rounded off. The boundary between the nostril inferiorly, and the alveolar part of the premaxillæ was not very sharply defined. In the young gorilla, also, the lateral boundaries formed by the ascending processes of the premaxillæ were much more rounded than in the adult. In the chimpanzee the anterior nares were triangular in form. The difference in shape in these two species of anthropoid apes was due to the different mode of termination of the ascending processes of the premaxillæ superiorly; and as this is a character on which Professor Owen has laid great stress, it is as well to note, that in all these gorilla's crania, as in those which he has described, the upper end of the ascending process of each premaxilla was intercalated as a triangular plate of bone between the nasal and superior maxilla. This could be readily traced both in the young skull and in that of the adult male, in which the naso- and maxillo-premaxillary sutures were visible, and in the adult female though the sutures were ossified, for lines on the bones indicated their original position. In the skull of the younger chimpanzee, in which alone the sutures persisted, and that, too, only at the ascending part of the premaxilla, the upper pointed end of that bone articulated with the lower end of the nasal, and was not intercalated between it and the superior maxilla.*

In the gorillas' crania the nasal bones were narrow, compressed, and projecting superiorly, and raised along their line of coalescence into a crest. In the young animal it could be seen that they projected upwards into the interorbital process of the frontal; and in this specimen a line, looking at first like a suture, but really only a groove, probably for an artery or a nerve, seemed to cut off the more expanded interorbital part from the narrower crest-like portion.* In the chimpanzee the nasal region was much flattened.

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* In the crania of the orangs and of the gibbons an arrangement of the upper end of the premaxillæ, closely similar to that described in the chimpanzee, was seen. In only one skull of the orang did a linear process of the premaxilla pass upwards for $\frac{3}{10}$ths of an inch between the nasal and superior maxilla. Hence the intercalated triangular plate at the upper end of the premaxilla of the gorilla is valuable as a diagnostic character to distinguish the skull of that animal not only from the skull of the chimpanzee, but from those of the other anthropoid apes. In the mode of termination, however, of its premaxillæ superiorly the gorilla closely corresponds with the arrangement seen in the skulls of many of the tailed apes, *e. g.*, Cynocephalus, Semnopithecus, Cercopithecus.

The interorbital region was in the gorilla wider near the floor than the roof of the orbit, and the fossa for the lachrymal sac was directed forwards. In the chimpanzee there was little difference in the width of the interorbital region at the floor and at the roof, the fossa for the lachrymal sac was directed outwards, and was concealed by the sharp edge of the inner end of the lower margin of the orbit. In the gorilla the os planum of the ethmoid was an elongated triangular plate of bone: in the young skull its apex did not reach the lachrymal bone, so that the orbital plate of the superior maxilla articulated with the frontal. In the adult crania the ossa plana articulated with the lachrymal bones.†

In all the crania of the gorillas the infra-orbital canals, as was first noticed by Agassiz, shallowed, and almost disappeared as they approached the spheno-maxillary fissures: in the chimpanzee they remained deep throughout, and in the male were quite, and in the younger animal almost, bridged over by a plate of bone posteriorly.

Owing to the comparative straightness of the alveolar portion of the premaxillæ, and the more elevated and elongated nasal bones of the gorilla, the profile outline of its face may be represented by a much more direct line than is possible in the chimpanzee, in which the deep nasal depression, lying between the interorbital and alveolar projections, gives a deeply concave character to the profile outline. In the profile view of all these gorillas' crania, not only was the outline of the nasal bones visible, but the lachrymal fossa, and a portion of the inner wall of the orbit behind the fossa.

In the skulls of the gorilla the emarginate form of the posterior margin of the hard palate was well seen. In the male gorilla, the depth of the posterior nares was almost twice as great as the breadth: in the female the vertical diameter was not so great as the transverse. In the young, one diameter almost equalled the other. In the adult male, and younger chimpanzee, the breadth exceeded the depth; in the female the two diameters were equal. The ratio of depth to breadth at these orifices was not, therefore, so definite as in the skulls described by Professors Owen and Wyman.

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* Dr Wyman states that in the crania he has examined there are indications of a suture separating the lower part of the nasals from the inter-orbital part, the latter of which he looks upon as an additional osseous element intercalated between the frontals. May not such a groove as the one described in the text have been regarded as a suture?

† So far as could be judged from the skull of the younger chimpanzee, in that animal the ethmoid did not articulate with the lachrymal by its anterio margin, the superior maxillary and frontal having processes intercalated between. In the orangs and gibbons, again, the ossa plana were quadrilateral plates, and articulated by their anterior margins with the posterior margins of the lachrymal bones.

In the lower jaws the following leading characters were noted:—Absence of chin; backward and downward slope of jaw from its incisive margin; presence of a strong buttress of bone on the inner aspect of symphysis; passage of horizontal into ascending ramus by a gentle curve; alveolar margins for molar and premolar teeth almost parallel; long axes of condyles almost transverse.

In the skull of the young gorilla various points illustrating peculiarities in the dentition were noticed. In the upper jaw the permanent incisors had emerged, the central pair being larger than the lateral pair. The milk canines were shed, but the apices of the permanent canines had only reached the orifices of their alveoli, the teeth being still buried in the jaw; the septum originally situated between the sockets for the temporary and permanent canines was in a great measure absorbed: the diastema between the lateral incisor and canine, so strongly marked in the adult male and female, but more especially in the former, had not yet originated; the septum between the sockets for those teeth was but little thicker than that between the alveoli for the lateral and central incisor, and the maxillo-premaxillary suture passed along the middle line of this septum.* The premolars had each two cusps, the external of the anterior, and the internal of the posterior being the larger: each premolar had three fangs, a larger internal and two smaller external. In the chimpanzee crania the fangs of the premolars differed somewhat from those of the gorilla, for though each of the first pair possessed three fangs, those of the second had only two fangs, an external and an internal; and in this respect, therefore, they presented a closer approximation to the arrangement of the fangs of the premolars in man than did the gorilla.

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* In the formation of the diastema in the crania of some apes, it would appear as if the premaxilla and the canine portion of the superior maxillary bone participated in an equal degree, for the maxillo-premaxillary suture was mostly situated, in the adult jaw, about midway between the canine and lateral incisor teeth. In others, however, *e. g.*, several cynocephali, the suture was placed much nearer the canine tooth, and the interval was occasioned by an increased growth of the premaxilla between that suture and the socket for the lateral incisor.

In the young gorilla the first and second pairs of true molars were fully erupted; each tooth was quadricuspid; the anterior internal was connected to the posterior external cusp by an oblique ridge. The third true molars were concealed within their alveoli.

In the lower jaw of the young gorilla the permanent incisors were erupted: the left milk canine was in its socket, and close to it, on its lingual side, was a foramen which led into a canal that communicated with the crypt containing the permanent canine; the foramen and canal marked the position of the gubernaculum. The right milk canine was shed, but the permanent tooth was deep in its alveolus, and the bony septum between the socket for the milk tooth and the gubernacular canal was still unabsorbed. The diastema which existed on each side of the canine, but more especially on the premolar aspect in the adult crania, had not been developed in the young skull. The first pair of premolars was considerably larger than the second, each tooth possessed an anterior and a posterior fang. The first and second pairs of true molars were erupted, each tooth was quinquecuspid; the third pair of true molars was still concealed within the jaw. The eruption of the permanent canines in the upper jaw precedes, therefore, their appearance in the lower jaw; but in both the upper and lower maxillæ the permanent canines follow in their eruption the first and second pairs of true molars.

The internal capacity of the crania was as follows:—

	Cubic Inches.
Adult male gorilla, ...	28·
Adult female „	26·5
Young female „	23·
Adult male chimpanzee, ...	22·
Adult female „	24·
Younger „	21·

Extreme length between the alveolar margin of the intermaxillary suture and middle of lambdoidal crest, measured in a straight line, was in the adult male gorilla 10·7 inches; in the adult female, 8·9 inches; in the young female, 7·5 inches. The length, measured in a straight line, between the interorbital ridge and the middle of the lambdoidal crest, was in the adult male gorilla 6·9 inches; in the adult female, 6 inches; in the young female, 5·1 inches.

2. Notice of a Remarkable Piece of Fossil Amber. By Sir David Brewster, K.H., F.R.S.

The piece of amber, now on the table, was found in the kingdom of Ava, and sent to me from India by the late Mr George Swinton, to whom the Society was indebted for many interesting objects of natural history from that country. It weighs 2½ lbs., and in its general aspect seems to differ considerably from the ordinary specimens of amber. The remarkable fact, however, which distinguishes it from all the specimens of amber I have seen or read of, is, that it is intersected in various directions by thin veins of a crystallised mineral substance. These veins are in some parts of it as thin as a sheet of paper, and in other parts about the twentieth of an inch thick. In order to determine the nature of the mineral I extracted a portion of the thickest vein, and having obtained, by cleavage, a small rhomb, I succeeded in measuring the inclination of its planes, and found it to be carbonate of lime.

Pieces of amber of 2 or 3 lbs. weight are very rare. A specimen weighing 1 lb. is valued in Prussia at 50 dollars. The largest piece yet found is in the Royal Museum at Berlin; it weighs 18 lbs., and is said to be worth upwards of 7000 dollars.

3. On the Cause and Cure of Cataract. By Sir David Brewster, K.H., F.R.S. Lond. and Edin.

The author's attention was called to this subject in consequence of having had an attack of incipient cataract forty years ago. The laminæ of the lens had separated so much as to exhibit rays of light, and the prismatic colours, round every source of light. At the end of eight months the laminæ came into optical contact, the rays and colours disappeared, and the eye became as perfect as the other,—a proof that cataract, in its incipient stage, may be discovered optically, and may be cured. During a series of experiments on the changes in the crystalline lenses of animals after death, the author observed that the capsule of the lens transmitted water into the lens till it burst; and hence he concluded that cataract might arise from an unhealthy state of the aqueous humour,—hard cataract from too much albumen in the aqueous humour, and soft cataract from too much water. The aqueous humour should therefore be evacuated, in order that nature might supply a more healthy secretion, or an artificial aqueous humour should be injected into the aqueous chamber,—operations that may be easily and safely performed. The evacuation of the aqueous humour was long ago tried with safety forty times on the same patient, in the Manchester Infirmary, for conical cornea; and the author of this paper has learned, since it was read, that M. Casimir Spirone of Turin has cured numerous cases of cataract by the evacuation of the aqueous humour, repeated thirty, forty, and even ninety times.

4. On the Hill Forts, Terraces, and other remains of the Early Races in the South of Scotland. By W. Chambers, Esq. of Glenormiston.

The district referred to included Roxburghshire, Selkirkshire, and Peeblesshire, in which Mr Chambers had visited and examined about 200 hill forts. These ancient works are found on the tops of hills of moderate elevation, and are of different classes, shewing a progressive improvement in construction. Those of the smaller kind consist of one or two concentric rings of earth and stone, with a clear space in the centre, and measure from 150 to 250 feet across. Such are considered to be the earliest in construction, and are at the least 2000 years old, though they may have been kept in use later. Their first constructors were unquestionably the aboriginal Celtic tribes, to whom they served as places of refuge and defence in petty local wars, or on the occasion of invasion. Originally, the entrenchments or rings may have been ten to fifteen feet in height, but now lying in ruins and covered with sward;

their height is seldom more than four or five feet. Between these very ancient forts and those in other parts of Scotland there is so little difference, that they may all be imputable to the same early races.

The hill forts of a more advanced kind demonstrate such skill in construction, that they may fairly be referred to a period coeval with and subsequent to the Roman invasion. Like the lesser forts, they are all circular or oval in form, but they comprehend four or even five concentric entrenchments with deep intervening ditches, and zigzag entrances, which an enemy would find it difficult to penetrate in the face of a body of defenders. The height of the still surviving rings in some of these forts is as much as twenty-five feet. When constructed, the walls would of course be much higher, and supplemented with stockades of wood, wattle, and the skins of animals, as was the case with the hill forts of the Gauls, described by Cæsar. In several instances, Mr Chambers had found exterior defences, in the form of high ramparts, making an irregular sweep, so as to enclose six or seven acres. Such enclosures were probably designed for the reception of cattle. Two of the more remarkable of these elaborate forts are Milkiston Rings, near Eddleston, and Henderland-hill Rings, parish of Newlands; both had evidently been designed to guard the great passes from the east—that is, to stem the tide of invasion of Angles, Frisians, and others approaching from the German Ocean.

Of the origin of the hill forts in the south of Scotland, the present inhabitants can give no account. Generally they are spoken of as being *Danish*—a curious error arising from a misapprehension of the legendary term *Dinas*, which in the original British signified fortress, and is still so applied in Wales. This word *Dinas* is found under varying forms in many ancient languages, and is the original of the names of places in Scotland corruptly called *Tinnies.* While the forts in question are not Danish, neither are they Roman, as is evident from their peculiar form. After comparing them with a Roman camp—a *castra stativa*—at Lyne, Mr Chambers proceeded to describe the Catrail, or great barricade which stretches across the country from near Galashiels to the mountains of Northumberland, a military work also designed to check invasion from the east.

He then gave some account of the hill terraces of the early races, of which there had been numberless speculations; he agreed with recent inquirers in thinking that they were simply designed for horticultural and agricultural purposes. Mr Chambers, lastly, drew attention to the rudely shaped monumental stones in the Vale of Tweed, on which he had found no elaborate or artistic sculptures, such as occurred in northern districts. Recent investigations concerning upright stones have happily put to flight a variety of those mythic legends and fables which were at no distant date the reproach and pollution of our topographic literature. As regards the whole of the interesting memorials of past times which had been adverted to, Mr Chambers trusted that the Society would join with him in the wish that land proprietors would, as far as practicable, make some effort for their preservation.

[The paper was illustrated with a number of large pictorial drawings.]

5. On the Molecular Constitution of Organic Compounds, No. I. By Alfred R. Catton, B.A., Fellow of St John's College, Cambridge, Assistant to the Professor of Natural Philosophy.

The author stated this to be the first of a series of papers, in which he intended to develop in detail a new theory of the molecular constitution of organic and inorganic compounds.

In this paper the author considers the constitution of the olefines $C_{2n}H_{2n}$, aldehyds $C_{2n}H_{2n}O_2$, fatty acids, hydrides of alcohol radicles $C_{2n}H_{2n+2}$, alcohols $C_{2n}H_{2n+2}O_2$, glycols $C_{2n}H_{2n+2}O_4$. ($C=6$, $O=8$.)

The following Donations to the Library were announced:—

Jahresbericht über die Fortschritte der Chemie und verwandter Theile anderer Wissenschaften für 1863. II. Heft. Giessen, 1864. 8vo.—*From the Conductors.*

Annual Report for 1864 of the Geologists' Association. London. 8vo.—*From the Association.*

Monthly Notices of the Royal Astronomical Society. Vol. XXV. No. 2. London. 8vo.—*From the Society.*

Journal of the Statistical Society of London. Vol. XXVII. Part 4. London. 8vo.—*From the Society.*

Memoirs of the Geological Survey of India. Vol. III. Part 2. Vol. IV. Part 2. Calcutta. 8vo.—*From Thomas Oldham, LL.D.*

Annual Report of the Geological Survey of India, and of the Museum of Geology. Calcutta, 1863–64. 8vo.—*From the same.*

Astronomical Observations made at the Observatory of Cambridge. By the Rev. James Challis, M.A., F.R.S., &c. Vol. XX. Cambridge. 4to.—*From the Observatory.*

Kongliga Svenska Vetenskaps-Akademiens handlingar. Band IV. Heft 2. Stockholm, 1862. 4to.—*From the Royal Academy of Sciences, Stockholm.*

Meteorologiska Iakttagelser Sverige utgifna af Köngl. Svenska Vetenskaps-Akademien Anställda och Bearbetade under inseende af Er. Edlund. Band IV. Stockholm, 1862. 4to.—*From the same.*

Oefversigt af Kongl. Vetenskaps-Akademiens Forhandlingar. Band XX. 1863. Stockholm, 1864. 8vo.—*From the same.*

Mémoires de l'Académie Impériale des Sciences de St Pétersbourg. VII^e Serie. Tome V. Nos. 2–9. Tome VI. Nos. 1–12. St Petersburg. 4to.—*From the Academy.*

Bulletin de l'Académie Impériale des Sciences de St Pétersbourg. Tome V. Nos. 3–8. Tome VI. Nos. 1–5. Tome VII. Nos. 1, 2. St Petersburg. 4to.—*From the same.*

Proceedings of the Royal Society. Vol. XII. No. 70. London. 8vo.—*From the Society.*

A New General Theory of the Teeth of Wheels. By Edward Sang, Hon. F.R.S.S.A., &c. Edinburgh, 1852. 8vo.—*From the Author.*

A Treatise on the Valuation of Life Contingencies, arranged for the use of Students. By Edward Sang, F.R.S.E. Edinburgh, 1864. 8vo.—*From the Author.*

Monthly Return of the Births, Deaths, and Marriages registered in the Eight Principal Towns of Scotland, December 1864. 8vo.—*From the Registrar-General.*

Redevoering ter Aanvaarding van het ambt van Buitengewoon Hoogleeraar aan de Hoogeschool te Leiden, den vijf en Twintigsten September 1863, uitgesproken door Dr D. Bierens de Haan. Deventer, 1863. 8vo.—*From the Author.*

Godefroid de Bouillon à Boulogne-sur-mer, à Bruxelles, et à Jerusalem—Lettre à M. le Comte d'Hericourt, par le Baron de Hody. Bruxelles, 1863. 8vo.—*From the Author.*

Coup-d'œil sur l'Eploitation de la Houille en Angleterre et sur les derniers perfectionnements qui y ont été introduits par M. Guillaume Lambert. Bruxelles, 1864. 8vo.—*From the Author.*

Proceedings of the Royal Horticultural Society. Vol. V. No. 1. London, 1865. 8vo.—*From the Society.*

The Journal of the Chemical Society, London. December 1864. 8vo.—*From the Society.*

Proceedings of the Royal Geographical Society, London. Vol. IX. No. 1. 8vo.—*From the Society.*

Journal of the Proceedings of the Linnean Society, London. Vol. VIII. No. 30, Zoology. 8vo.—*From the Society.*

Monday, 6th February 1865.

SIR DAVID BREWSTER, President, in the Chair.

At the request of the Council Mr Geikie gave the following Account of the Progress of the Geological Survey in Scotland, illustrated by Maps and Sections:—

The object of the Geological Survey is to ascertain in detail the geological structure of the United Kingdom, and to publish the results in maps, sections, and descriptive memoirs. The Ordnance maps form the groundwork on which these geological investigations proceed; and as no district is examined until these maps are ready, the progress of the Geological Survey is guided in no small degree by that of the Ordnance engineers. In Scotland, the geological mapping has hitherto been conducted wholly upon the county maps on the scale of six inches to a mile, and the advantages of so large a scale are such, that although the work is finally reduced and published on the scale of one inch to a mile, no county is surveyed until its six-inch maps are ready for use. By this means a much more detailed and accurate map is given than if all the minutiæ of a difficult district had to be surveyed upon so small a scale as that of one inch to a mile.

The survey of Scotland was begun by Professor A. C. Ramsay, the local director, towards the close of 1854. East Lothian was selected as the point of commencement best suited for the investigation of the Lothian coal-fields, and the work was carried steadily westward from the older Silurian rocks into the coal-basin. Much inconvenience arose, however, from the backward state of the Ordnance maps. In Haddingtonshire, all the sheets were unfinished, and those of Berwickshire were not even engraved. Hence the map containing the earliest labours of the survey—the geology of East Lothian—had to lie aside for several years until the Ordnance sheets of Berwickshire could be obtained to complete it. The westward progress of the survey was at last abruptly stopped by the want of the maps of Stirlingshire. The work was then transferred to Fife, and nearly the whole of that county and of Kinross was completed by the end of the year 1861. But only the eastern part could be published; nor was it until last spring that the sheets of Perthshire, still far from being complete, were obtained to allow of the Fife work being finished. That map is now in the hands of the engraver.

As no further advance could be made either to the north or west, the only available direction was the south. Accordingly, in the early part of 1862, the survey of Peeblesshire and Lanarkshire was begun, and at the end of 1863, an area of 432 square miles was ready for the engraver, including Peeblesshire, with parts of Lanark and Selkirk. On application to the Ordnance Survey, however, it was found that though all the six-inch maps of the county of Peebles had been some time published, and an outline map on the one-inch scale was also engraved, the one-inch shaded map, on which the geological information is inserted, would not be ready for two years. This large area, therefore, remains unpublished, and cannot make its appearance until the one-inch shaded map is completed.

It had been earnestly desired that the surveys of the great central coal-fields should first be prosecuted, but the delay in the completion of the Ordnance maps made it at last necessary to stop altogether the examination of the midland counties. The geological survey was then, in the autumn of 1863, transferred to Ayrshire, of which the county Ordnance map is published. Considerable progress has been made there, and it is intended to work northward from the Silurian boundary, so as to complete the survey of the Ayrshire coal-fields with as much speed as the nature of the work will permit.*

The staff of the Geological Survey in Scotland has always been very small. For the first seven years, there were only two geologists, their labours being aided by a yearly visit from Professor Ramsay, and by the occasional personal assistance of the palæontologist. One of them, Mr Howell, whose experience, especially in the details of coal-field surveying, was of essential service, then left, and three surveyors were successively appointed. Some time, however, had necessarily to elapse before they were able to carry on independent work. This they are now doing; and as, in the south-west of Scotland, the Ordnance maps have all been published, it is believed that the Geological Survey will now be enabled to advance with greater comfort and speed.†

Notwithstanding the hindrances which have impeded progress hitherto, a considerable area of the country has been examined. The state of the survey at the end of last year was as follows:—

	Square Miles.
Area published on the one-inch scale, .	963
Area engraving on the one-inch scale, .	382
Area surveyed but not engraved, . .	1169
Total area surveyed, .	2514

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* It is right to state that the above remarks are not intended to impute any blame to the way in which the Ordnance Survey has been conducted, but simply to explain why the Geological Survey has hitherto been able to do so little in the great coal-fields.

† From what has been said above relative to the state of the Ordnance Survey, it will be seen that though the staff of geologists has been small, it has been quite large enough for the number of maps available for geological purposes. The geologists have been all along treading closely on the heels of the Ordnance surveyors, and, to have increased the staff, would soon have brought the Geological Survey to a stand. What has been needed has not been more geologists, but more maps.

Besides the one-inch maps, however, there have been published detailed maps on the scale of six inches to a mile of the coal-fields of Edinburgh, Haddington, and part of Fife, and it is intended to continue the series through the other coal-basins. Horizontal sections, on the same large scale, have likewise been issued; one of these stretches from Edinburgh, through Arthur Seat and the Garlton Hills, to the coast near Dunbar; two others cross Mid-Lothian to the Lammermuir Hills, showing the structure of the Pentland Hills and of the Edinburgh coal-field. Descriptive memoirs of the neighbourhood of Edinburgh and of the East of Berwickshire have been published to illustrate sheets 32 and 34 of the geological map, and others of Fife and East Lothian are in preparation. A large collection of specimens of the rocks and fossils of the Lothians, Fife, and the south-west of Ayrshire has been made in duplicate, one series being deposited in the Industrial Museum, Edinburgh, the other in the Museum of the Geological Survey, London.

Among the scientific results of the survey, by which fresh light has been thrown on the geological structure of Scotland, mention may be made of the discovery of well-marked graptolites (*Graptolithus priodon* and *Diplograpsus pristis*) among the Silurian rocks of the Lammermuir chain, shewing that these strata are probably the equivalents of the Llandeilo and Caradoc formations of Wales. A considerable addition has likewise been made to the known list of fossils from the lower Silurian limestones and shales of Peeblesshire, while in Ayrshire, a large suite of shells, trilobites, corals, and other organic remains, has recently been made from the lower and upper Silurian rocks, and is now under examination in the Museum, Jermyn Street. The discovery of a numerous group of well-preserved fossils in the shales and mudstones of the Pentland Hills proved these strata to be of the age of the Ludlow rocks, a position much higher than had before been given to them.

In the Old Red Sandstone, much interesting work has been accomplished. It has been ascertained that this formation in the Lowlands of Scotland is capable of subdivision into three zones. The lowest of these is well seen between Tinto and the confines of Ayrshire. It merges into the upper Silurian shales of Lesmahagow, and is covered unconformably by all later rocks. In the

Pentland Hills, the Upper Silurian beds pass upward into certain red conglomerates and sandstones, which are supposed to be the base of the Lower Old Red Sandstone. This same lower member of the formation occurs in the east of Berwickshire, where it consists, to a large extent, of volcanic ash and conglomerate, but it has yielded fragments of *Pterygotus* and plants.* The Ochil Hills are formed of a series of felspathic lava-beds, with interstratifications of sandstone and volcanic conglomerate, the whole belonging to the Lower Old Red Sandstone. The structure of the hills, as made out by the Survey, is shown in the subjoined sketch (fig. 1).†

The middle division of the Old Red Sandstone is seen in the chain of the Pentland Hills, where it consists of a mass of coarse conglomerate and grit, overlaid with a great thickness of felspathic lava-form and ashy rocks. It lies on the worn edges of the Upper Silurian and of the red-coloured strata, which are supposed to indicate the bottom of the Lower Old Red Sandstone. No fossils have yet been detected in any part of it, so that no means exist of deciding how far it represents the great Caithness flagstone series. On the denuded ends of the rocks of this central group come the conglomerates and sandstones of the upper division, which pass upward into the Carboniferous system. In the accompanying diagram across the Cairn Hills in the Pentland Chain, the gene-

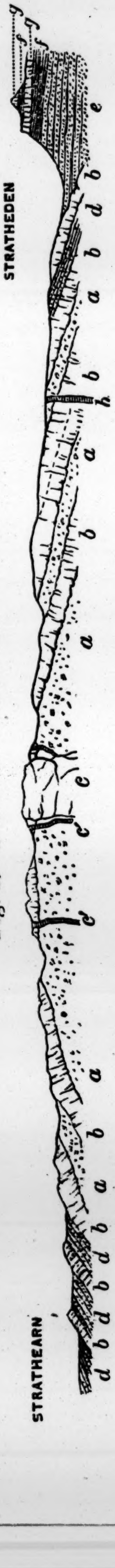
WEST LOMOND
STRATHEDEN
STRATHEARN
d b d b d b a b a b a c′ c′ c a b a h b a b a b d b e f f g g

Fig. 1.—Sketch-section across the Ochil Hills.

a, Volcanic ash and conglomerate; *b*, Felstone lava-beds; *c*, Intrusive felstone, like old volcanic "neck;" *c′*, Dykes of felstone most abundant round these "necks;" *d*, Sandstones, shales and conglomerates of the Lower Old Red Sandstone; *e*, Upper Old Red Sandstone; *f*, Carboniferous shales, limestones, &c.; *g*, Intrusive greenstone of the Lomond Hills; *h*, Greenstone dyke.

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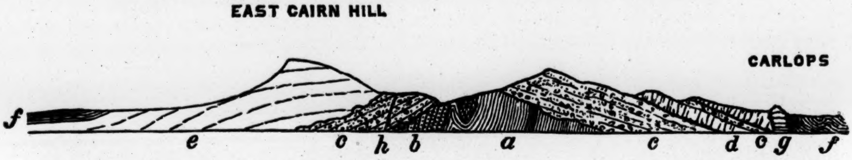
* See "The Geology of Eastern Berwickshire," Mem. Geol. Survey, p. 27.

† This section combines in a generalised form the result of the survey made in concert by my colleagues, Dr John Young, Mr James Geikie, Mr B. N. Peach, and myself.

ral relation of the rocks between the Carboniferous and Upper Silurian formations in the middle of Scotland is shown.

Fig. 2.—Sketch-section across the Cairn Hills, Pentlands.



a, Upper Silurian shales; *b*, Red sandstones and conglomerates, supposed to be the base of the Lower Old Red Sandstone; *c*, Thick conglomerates and grits, forming a Middle division of the Old Red Sandstone; *d*, Felstone lava-beds, interbedded with *c*; *e*, Upper Old Red Sandstone; *f*. Carboniferous sandstones, shales, &c.; *g*. Intrusive greenstone coming up along a line of fault; *h*, Fault.

The Upper Old Red Sandstone has been mapped by the Survey throughout the Lothians and Fife, and has been traced southwards far into Berwickshire, and south-westwards into the uplands of Lanark. Traces of contemporaneous volcanoes at the top of the Old Red Sandstone have been found near Dunse, in Berwickshire,* and near Dunsyre in Lanarkshire.

The mapping out of the various subdivisions of the Carboniferous rocks has opened up some curious questions regarding the ancient physical geography of the country, and unequal oscillations of level during the Carboniferous period. It has likewise shown that, during the earlier half of that period, the basin of the Forth was dotted over with little volcanic cones, which sometimes threw up each its mound of ash or current of lava, and sometimes coalesced to form long banks of volcanic ejections, over which the limestones and coals were slowly elaborated. The subdivisions of this formation adopted by the Survey in the districts yet examined are—

		English Equivalents.
Coal-measures	=	Lower part of English Coal-measures.
Millstone grit, or "Moor rock"	=	Millstone grit.
Carboniferous limestone series. A group of sandstones, shales, and coals, with several bands of limestone in the upper part, and some thicker beds below	=	Rocks between the millstone grit and the lower limestone shales.
Calciferous sandstones	=	Lower limestone shales.

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* I may mention in passing, that Ruberslaw, and perhaps some of the felspathic hills of that district, seem to mark the site of volcanoes of the time

Much attention has been paid to the drift and superficial deposits. The subjoined table shows the subdivisions which are at present followed in mapping these formations on the ground :—

Alluvium.
Blown Sand.
Peat.
Raised Beach deposits.
Old River-terraces.
"Surface-wash,"—a deposit of sand, clay, gravel, or shingle, frequently containing scratched stones, and found on the high grounds of the southern uplands.
Moraine rubbish of valley glaciers.
Erratic blocks.
Re-formed Drift. Sands and gravels of the *Kame* or *Esker* series. Brick-clays, with Arctic shells.
Upper Boulder-clay.
Lower Boulder-clay.

Roches moutonnées (striæ effaced), are marked . ⬭
Do. do. striated, but not showing distinctly from which quarter the ice moved . . . . —⬭—
Do. do. showing direction of ice-flow . —⋲—
Flat surface of striated rock, such as is often seen under the Boulder-clay . . . . . . —o—
Do. showing the direction of ice-flow . . ←o—

The subdivision of the Boulder-clay into two zones was decided upon in the autumn of 1863, and since then the division has been carried out wherever practicable. The upper Boulder-clay is a looser, more gravelly deposit than the lower, and seems to have suffered a greater denudation. It has usually a more or less obscure stratification, contains a considerable admixture of travelled stones, with occasional fragmentary shells, and is regarded as having been formed in the sea, a short way off the land, by bergs from a dis-

of the Upper Old Red Sandstone. The hills to the south-west of the town of Ayr are formed of felstones and ashy conglomerates, which appear to belong to some part of the Old Red Sandstone period. They are at present under investigation by the Geological Survey.

tance, as well as by masses of ice from the adjacent shores dropping their loads of mud, earth, and stones to the bottom. The lower Boulder-clay or *till*, on the other hand, seems to have gathered partly on the land, and partly under the ice-sheet which pushed its way out to sea.* This took place when the land was undergoing a submergence, so that the lower Boulder-clay might be accumulating on the land and along the coast-line, while the upper part of the deposit was being formed from the droppings of floating ice some way further out at sea. The following tables give the percentage of stones in the two clays on the line of the new railway near Newhaven, and show the markedly local character of those in the lower zone, and the mixture of erratic boulders in the upper :—†

Upper Rudely Stratified Clay (near Man-Trap).

From the Highlands, 9 per cent.	Per cent.
Mica-schist, . . .	6
Purple cleaved slate, .	1
Metamorphic grit, . .	2
From the Ochil Hills, 16 per cent.	
Red felstone, . . .	2
Pink „	2
Blue „	1
Purple „	1
Pink porphyry, . .	4
Purple „	2
Green „	1
Red felspathic sandstone, .	2
Felspathic conglomerate, .	1
Doubtful; either from the Ochils or from the Lower Carboniferous rocks, 12 per cent.	
Quartz pebbles, . . .	9
Quartz-rock pebbles, . .	3

From the Carboniferous rocks of the Basin of the Forth, 63 per cent.	Per cent.
White and grey sandstone,	25
Black shale, . . .	8
Ironstone, . . .	8
Coal, ...	6
Basalt, ...	2
Greenstone, . . .	9
Ash, ...	1
Cement stone, . .	1
Cyprid limestone (= Queensferry or Burdie House),	1
Cyprid shale, . . .	2
	100

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* This view of the origin of the till was proposed by me in October 186 and published in the following spring in my "Memoir on the Phenomena of the Glacial Drift of Scotland," and a woodcut was there given (p. 99) to show how the deposit might contain the remains both of land plants and of sea-shells.

† These percentages were taken in September 1868, in company with my colleague, Dr Young.

Lower Boulder-Clay or True Till.

	Per cent.
White and grey sandstone,	30
Corstorphine greenstone,	22
Common greenstone,	12
Shale of the calciferous sandstone series,	12
Basalt,	6
Quartz pebbles,	4
Cyprid limestone,	4
Encrinite limestone,	3
Ironstone,	2
Felspathic greenstone,	2
Greenstone of Mons Hill,	1
Cement stone,	1
Ash,	1
	100

The list of stones from the lower clay shews with clearness the easterly movement of the ice. The most abundant are from rocks that occur *in situ* immediately to the west, and the further removed the parent mass, the smaller and rarer are the fragments of it in the clay. It is to be noted that all the stones are derived from rocks that occur in the district; even those which have come furthest need not have travelled more than eight or ten miles. In the railway cutting, this lower clay had its upper limit marked off by a band of large boulders, chiefly of greenstone, sometimes measuring a yard across, and occasionally well striated. The rock of Corstorphine Hill was well represented among these boulders, and there were likewise blocks of porphyritic felstone and encrinite limestone. Above the line of boulders lay an extensive deposit of gravel and sand, which, eastward, nearer the Man Trap, gave place to an upper sandy clay, in which the stones were found to be more rounded than in the lower clay, comparatively seldom striated, and to bear evidence of having come from longer distances. In the list above given, it will be seen that more than three-fifths of these stones come, like those in the till below, from the carboniferous rocks of the basin of the Forth; that sixteen per cent. have travelled across that basin from the chain of the Ochils, a distance of at least five-and-twenty miles, while a still smaller number, nine per cent., has been carried from the flanks of the Highland mountains not less than five-and-forty miles away. Where the upper and under clays came together in the section, the band of boulders had disappeared, and the two deposits had no very marked line of demarcation between.

Although the sands and gravels of the Kame series have been traced and mapped by the Survey over a considerable area, their origin is still involved in great uncertainty. In the uplands of Peeblesshire, beautiful glacier moraines have been found, shewing the existence in these high grounds of a group of valley-glaciers after the re-elevation of the land.* Others, on a still larger scale, occur among the high grounds of the south-west of Ayrshire.

In the course of the explorations of the Survey, proofs of vast denudation have everywhere been met with, leading to the conclusion that the present inequalities of the surface—our hills and valleys, plains and river-gorges, are not directly due to upheaval and subsidence, or to fractures of the earth's crust, but must be attributed mainly to the unequal wearing away of the rocks by the sea, rain, springs, streams, and glacier-ice.

This address was illustrated by an exhibition of all the published maps, sections, and memoirs made by the Geological Survey in Scotland, by a large map, on the scale of one inch to a mile, shewing all the work which has been done, both published and unpublished, and by enlarged sections to explain the structure of the Ochil and Pentland Hills.†

The following Communication was read:—

On a New Bituminous Substance, imported under the name of Coal from Brazil. By T. C. Archer, Esq.

This material was brought from Brazil to Liverpool, for the purpose of ascertaining its commercial value in this country. The importers submitted it to Dr Edwards, who reported that it yields a much larger percentage of oil than even the celebrated coal of Torbane Hill.

The crude oil of the first distillation has a sp. gr. of ·859.

On redistillation, a light and heavy oil are obtained from the crude oil.

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* They have been carefully examined by Dr Young, who has given an account of them in the Quarterly Journal of the Geological Society for 1864.

† It is not usual to publish the results of the Geological Survey until they appear in the authorised and official form. In the present instance, I am indebted to the courtesy of the director-general, Sir Roderick I. Murchison who at once most cordially gave his sanction to the publication of the above abstract in the Proceedings of the Society.

The sp. gr. of the lighter is ·768.
Of the heavier „ ·858.

The lighter oil, when refined, is colourless, and resembles the oils obtained from coal, petroleum, &c.

Its sp. gr. is ·753.

The substance itself resembles, in general appearance, dried clay; but it is very light, being extremely buoyant in water. It breaks with a conchoidal fracture, and in some portions there are bands of minute striæ, indicating sedimentary deposition. Thin sections, which I have prepared with difficulty, show no trace of organic structure under the miscroscope.

No information was received with it as to the exact locality whence it was obtained, but in the Exhibition of 1862 similar substances were shown in the Brazilian collection, under the following titles:—

1. Schistos betuminosos calcareos—from the Serra de Araripe, in the Province of Ceara.
2. Schisto argilo-calcareo betuminoso—from Chapad, in the Province of Maranham.
3. Schisto betuminoso—from Pirapora, Province of S^{to} Paulo.
4. Schisto betuminoso—from the Morro do Taio, Province of Santa Catherina.
5. Schisto betuminoso—from Camaragibe, Province of Alagoas.

In all probability the specimen before this Society is from one of these localities; and the fact that it is so widely distributed in Brazil will stimulate further inquiry about so valuable a substance.

The following Donations to the Library were announced:—

Transactions of the Botanical Society of Edinburgh. Vol. VII. Part 1. 8vo.—*From the Society.*

General Index to the first 15 vols. of the Transactions of the Pathological Society of London, 1864. 8vo.—*From the Society.*

Abstracts of the Meteorological Observations made at the Magnetical Observatory, Toronto, C.W., during 1854 to 1859. 4to. Toronto, 1864.—*From the Observatory.*

Results of the Meteorological Observations made at the Magnetical Observatory, Toronto, C.W., during 1860, 1861, and 1862. 4to. 1864.—*From the Observatory.*

Philosophical Transactions of the Royal Society of London. Vol. CLIV. Parts 1 and 2. 4to. 1864.—*From the Society.*

Proceedings of the Royal Society of London. Vol. XIV. No. 71. 8vo.—*From the Society.*

Astronomical Observations made at the Royal Observatory, Greenwich, 1862. 4to.—*From the Observatory.*

Die Zeitbestimmung vermittelst des Tragbaren, Durchgangsinstruments im Verticale des Polarsterns, von W. Dollen. 4to. St Petersburg, 1863.—*From the Author.*

Preussische Statistik herausgegeben in Zwanglosen Heften, vom Königlichen Statistischen Bureau in Berlin, VI. 4to. Berlin 1854.—*From H. W. Dove.*

Materiaux pour la Carte Geologique de la Suisse, publiés par la Commission Geologique de la Société Helvetique des Sciences Naturelles aux frais de la Confederation, Deuxieme livraison. 4to. Berne, 1864.—*From the Society.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt Band XIV. Nr. 2, 3. 8vo. Wien, 1864.—*From the Society.*

Bulletin de la Société Imperiale des Naturalistes de Moscou, publié sons la Redaction du Docteur Renard. Nos. III. IV. 1863; No. 1. 1864. Moscow. 8vo.—*From the Society.*

The Mâhâbhashya of Pantanjali; a Commentary on the Grammatical Aphorisms of Panini, with the Glosses of Kailjata and Nâgogi Bhatta. Fol.—*From the Author.*